106 may be formed from hypodermic needles which are held in place by a sealant **104**, such as epoxy, contained in wells **102**. The embodiment for use with a stainless steel flow sheet **42** is substantially identical, but may omit holes **96**. A lower window (not shown) seals the side of flow sheet **42** opposite upper window **92**. Thin coverslips of 170 μm thickness for the lower window are available from Corning Glass Company.

An inner holder **110** is depicted in FIG. **5** for contacting the optical manipulation chamber formed from central flow sheet section **42**, upper window **92** and a lower window (not shown). Inner holder **110** clamps the optical manipulation chamber to enable effective heat transfer between the chamber and a surrounding outer shell (FIG. 7) to permit the application of mechanical shocks to the optical chamber to dislodge particles which may tend to adhere to the chamber walls, and to enable the optical chamber to be attached to a mechanical positioning system for relative movement of particles within the optical chamber.

Inner holder **110** includes an upper holder **112** and lower holder **122**, both of a material having a high heat transfer coefficient, such as brass. Upper holder **112** defines external port access cavities **118** for port connections **106** (FIG. **4**) and optical access port **114** for laser access to manipulation area **68** within central section **42**, and includes one or more temperature sensors **116** for use in controlling the temperature within central section **42**. Lower holder **122** defines optical chamber cavity **124** and optical access port **126**, and includes piezoelectric element **128** for transmitting short mechanical shocks to within the optical chamber.

An assembled inner holder **110** is depicted in FIG. **6**. Upper holder **112** is secured to lower holder **122** (not shown) by a clamping device, such as bolts **132**. Access to the external port connections **106** is provided through access holes **118**. Optical access to at least manipulation area **68** on central flow sheet **42** is obtained through optical access port **114**.

Outer shell **140** for connecting inner holder **110** to a positioning device and for pumping heat between central section **42** and the environment is shown in FIGS. **7A** and **7B** in cross-sectional view. Upper shell **142** defines optical access port **146** and electrical connector cavity **152** and includes a plurality of thermoelectric elements **148**. Lower shell **144** defines optical access port **156**, external port access openings **164**, and electrical connector cavity **158**, and includes a second plurality of thermoelectric elements **148**. Heat transfer fins **154** and **162** depend from outer shell **142** and inner shell **144**, respectively, to facilitate temperature control. Thermoelectric elements **148** thermally contact inner holder **110** for controlling the temperature within manipulation area **68** in central flow section **42** (FIG. **2**) as determined by temperature sensors **116** within upper holder **112** (FIG. **5**). Suitable thermoelectric elements require a maximum of 0.8 amps per element at 2.8 volts to provide a maximum heat transfer through each element of 0.95 watts.

Thus, the manipulation chamber assembly **12** (FIG. **1**) described above provides a microlaboratory for conducting experiments on microscopic particles. The multiple compartments in manipulation area **68** of central flow section **42** are the microscopic equivalent of test tubes between which particles can be optically transferred. Interconnecting channels **82–85** and valve compartments **75, 77** allow the composition of materials in the compartments to be selectively modified for controlled experiments. A variety of biological particles have been optically trapped and manipulated within chamber **12**, including mammalian cells (mouse thymocytes, spleen cells, and cultured fibroblasts, rat erythrocytes and alveolar macrophages, and human erythrocytes), plant protoplasts, and CHO chromosomes. A trapping laser power of 15 mW was used without any observed damage to the particles.

It will be understood that inner holder **110** and outer holder **140** can be formed as an integrated unit and still provide the requisite functions of temperature control and particle dislodgement. As described, the separate units provide easy fabrication and assembly, as well as access for possible maintenance on thermoelectric elements **148**.

The foregoing description of the preferred embodiments of the invention have been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto.

What is claimed is:

1. In a laser system for optically trapping and manipulating microscopic particles with the use of a particle control chamber the improvement comprising:

a manipulation chamber having a central section defining a plurality of inlet and outlet ports for introducing fluids and said particles within said chamber, a plurality of flow channels connecting said inlet and outlet ports, and a manipulation area optically accessible by said laser system;

said manipulation area further including a first enlarged volume in selected first ones of said flow channels usable for introducing said particles, each said first volume being effective to contain a selected number of said particles and interconnection channels for selectively interconnecting said first enlarged volumes.

2. A laser system according to claim **1**, wherein said manipulation chamber further includes window means for sealing said central section while enabling optical access to at least said manipulation area.

3. A laser system according to claim **2**, wherein said window means further includes connector means in sealing registration with said inlet and outlet ports for introducing said particles and fluids within said flow channels.

4. A laser system according to claim **2**, wherein said window means further includes electrode means operatively associated with said first enlarged volume for establishing an electric field within said first enlarged volume.

5. A laser system according to claim **1**, further including holder means for receiving and supporting said manipulation chamber while maintaining optical access to at least said manipulation area.

6. A laser system according to claim **5**, wherein said holder further includes means for supporting a piezoelectric transducer in proximity to said manipulation chamber effective for transmitting a generated shock